Will the measurement robots take our jobs? An update on the state of automated M&V for energy efficiency programs

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What is M&V2.0?

- Generally understood as: use of more data (interval or volume), analytics, computation at scale
  - to streamline the M&V process through semi/automation

- Delivered in proprietary tools, 'open' algorithms

What are the potential benefits of M&V2.0? What is the value proposition?

- Increase visibility, quickly obtain ongoing and interim results feedback
  - Increase savings and enhance customer experience?
  - Improve transparency and trustworthiness of EE savings?

- Automate parts of the process that computers do well, streamline data acquisition and processing
  - Reduce time and cost to quantify savings?
  - Maintain/improve accuracy in savings?
  - Increase throughput, number of projects going through the pipeline?

SCALE-UP

Screen shots of M&V2.0 capability

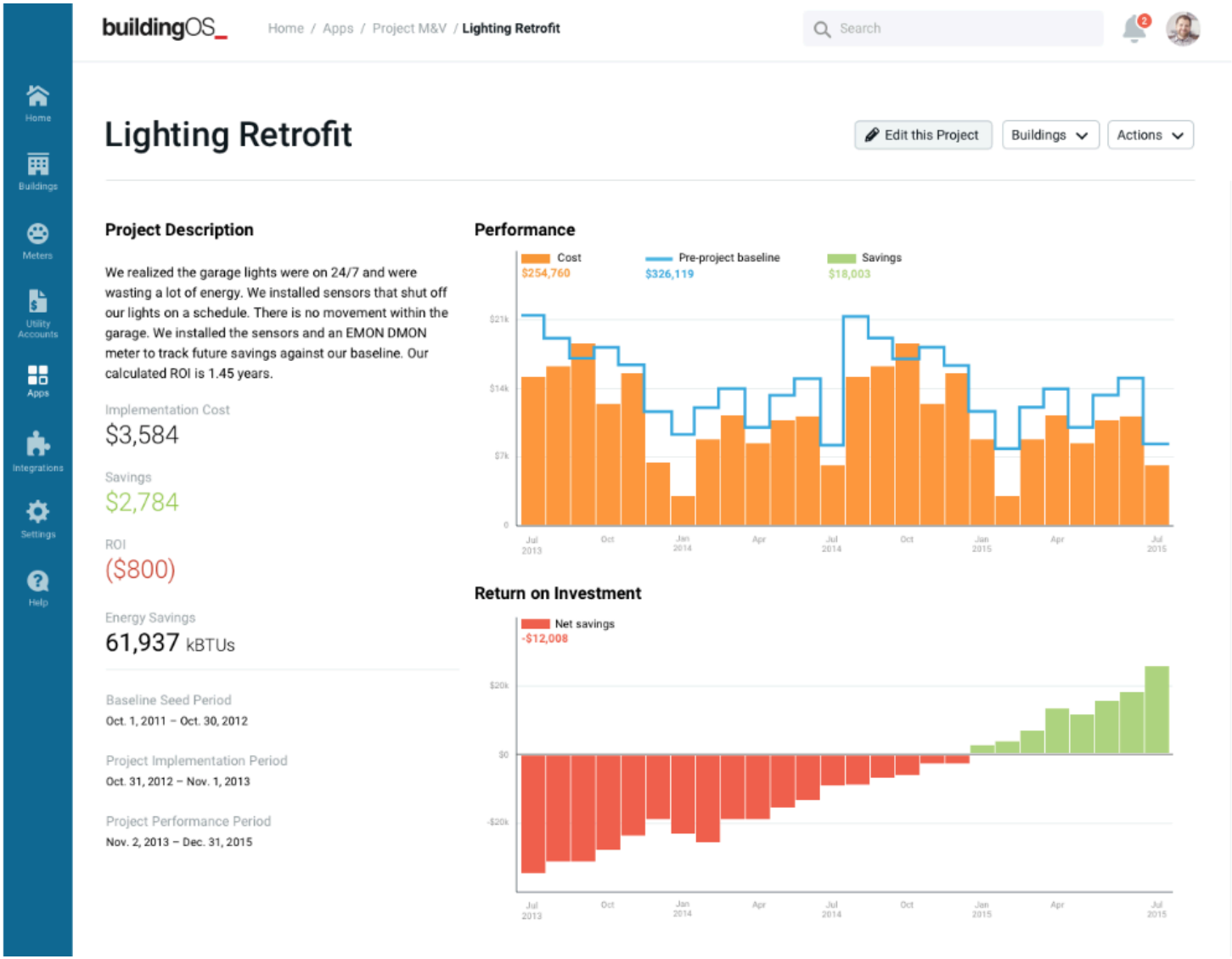

Image Source: Lucid

Screen shots of M&V 2.0 capability

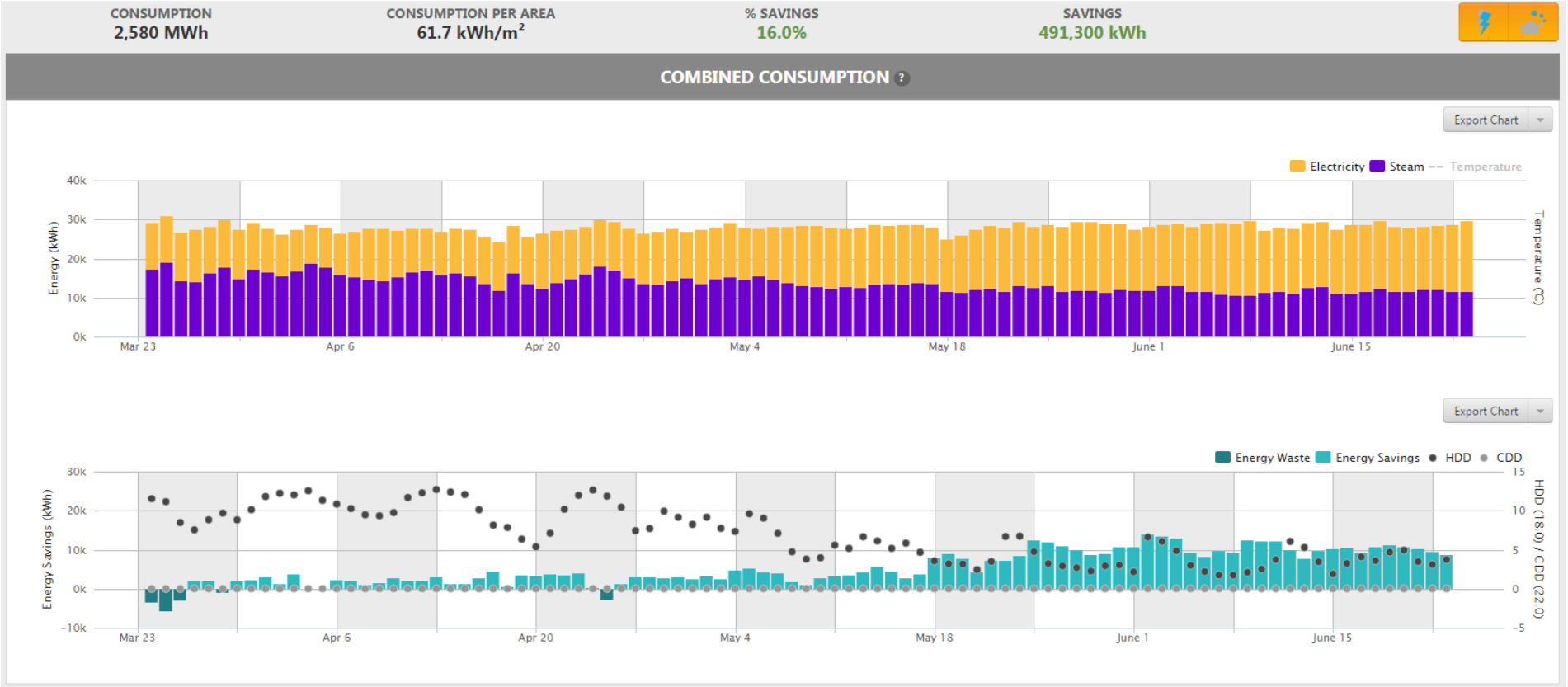

Image Source: EnerNOC

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Screen shots of M&V2.0 capability

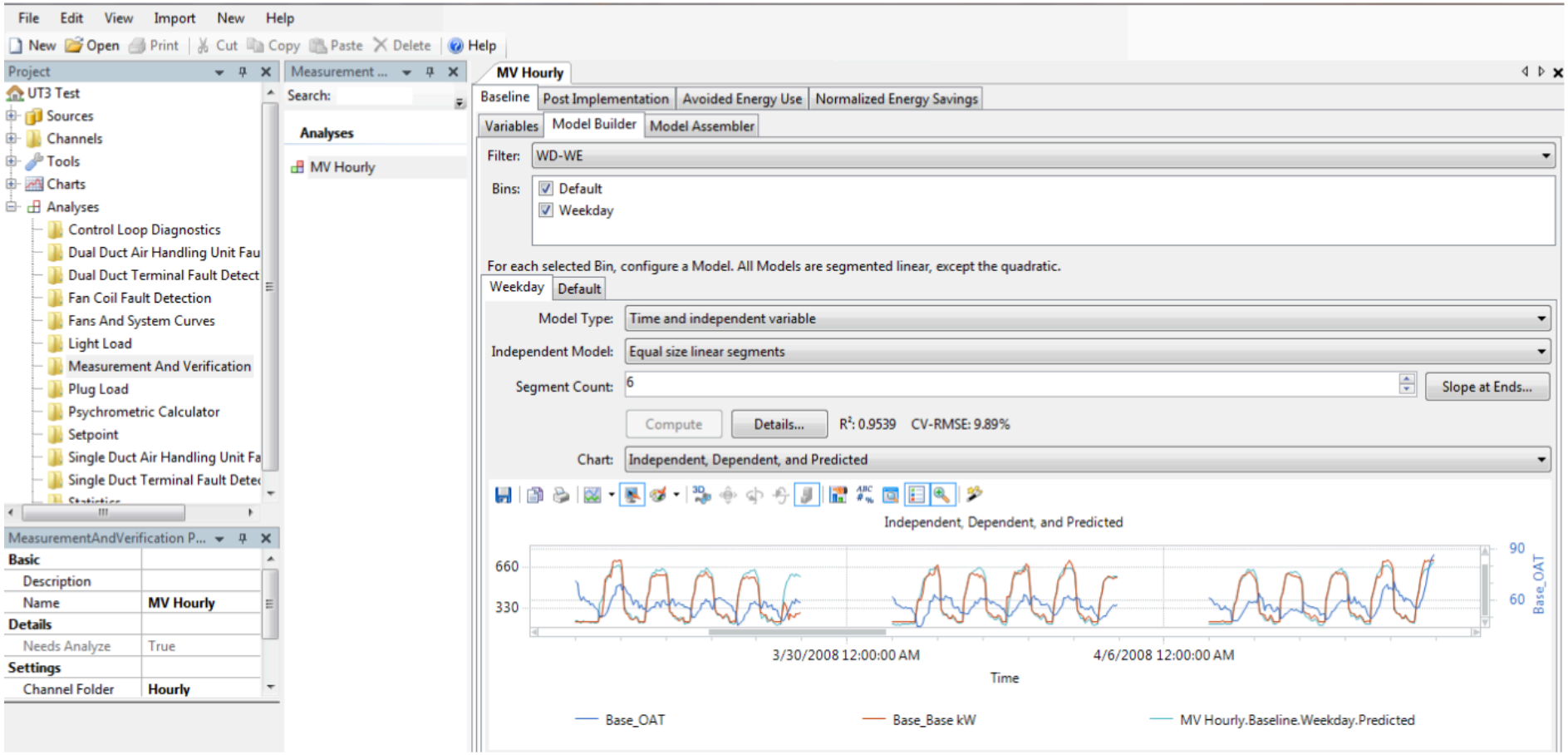


Image Source: Universal Translator 3

Promising opportunities associated with meter-based M&V approaches

- Enabling delivery of whole-building programs that combine strategies for deep savings
  - Retrofit, operational, behavioral, retro-commissioning
  - Difficult/expensive to quantify measures
- Enabling pay-for-performance programs
- Maximizing benefit of investment in AMI infrastructure

Motivating Industry Questions, R&D Approach, and Highlights

Industry questions motivate LBNL's R&D

- Are these proprietary tools reliable?
- How can I verify their accuracy and compare them?
- Even if a tool is generally robust, how do I know that it will work for my specific projects or program?
- How "big" do my savings have to be to use these approaches?
- How do I know that a robust tool was applied to generate a quality result?

Four-step R&D approach to answer these questions

1. **Population-level (many buildings) M&V2.0 testing to verify general, overall robustness, compare and contrast tools (last ACEEE)**

2. **'Off-line' demonstration of promising models with historic utility program data (today)**

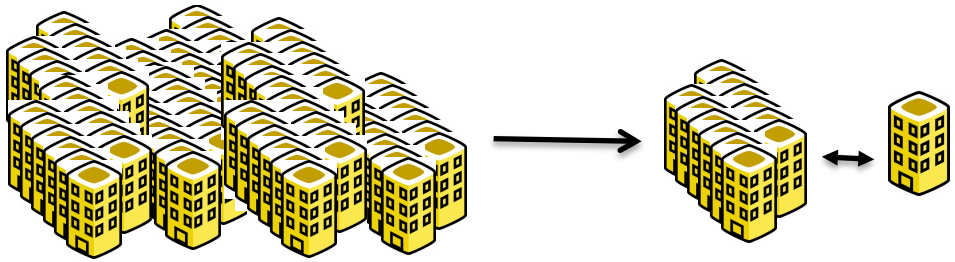
3. Identification of reporting requirements and quantitative acceptance criteria for savings claims (ongoing)

4. Larger pilots, demonstrations with 'live' projects (future)

Demonstrating 2.0 tools with historic program data

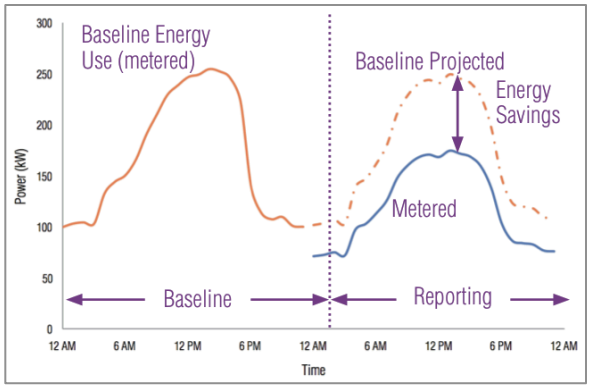
- Given tools that generally predict energy well, use them to automatically quantify savings

- Preliminary workflow, drawing from ASHRAE Guideline 14
  - Auto fit the model to data from baseline period, and compute goodness of fit metrics
  - Set aside buildings that do not meet suggested fitness thresholds - these will require further investigation
  - For 'good' buildings auto compute savings and uncertainty using M&V 2.0 tool
  - Aggregate savings and uncertainties for each building to determine portfolio-level results



Historic Program Data

- 3 commercial program data sets
  - Retrofit, RCx program
  - Custom program
  - Unknown measures

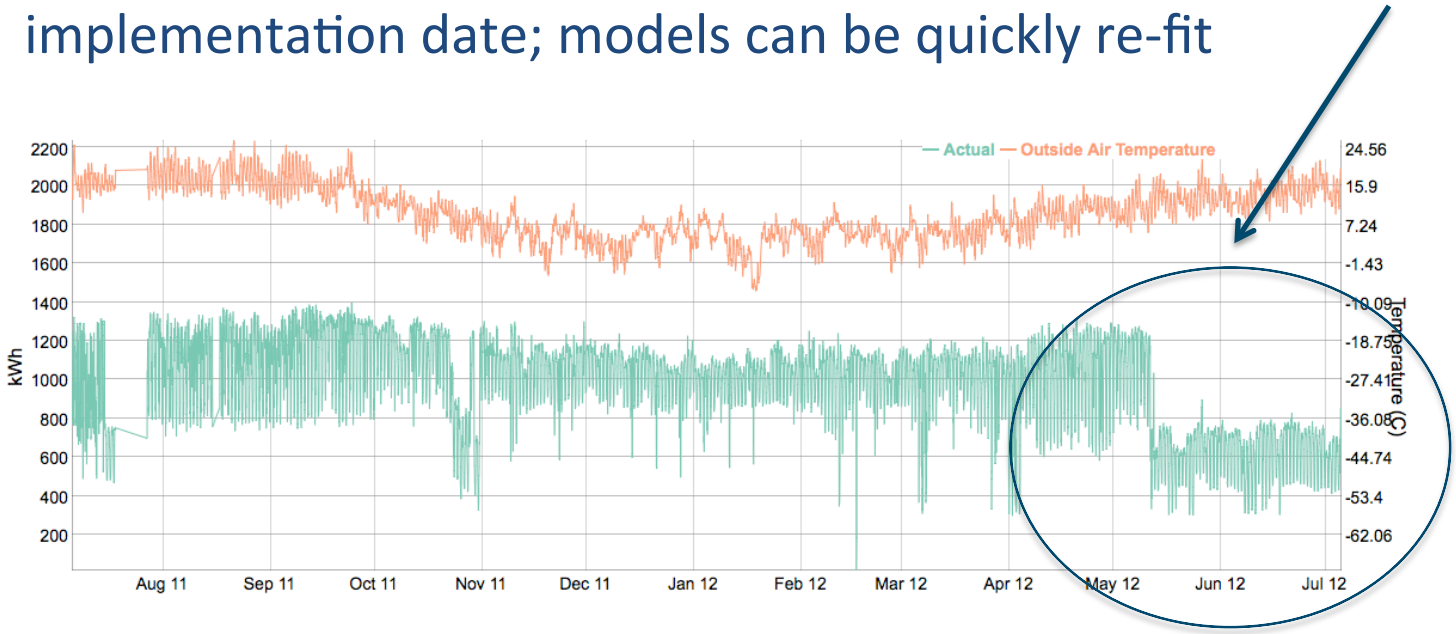


- Different information available for each
  - Previously calculated savings, labor time estimates, project details, non-routine events, measures

- >= 9mo pre/post interval data, outside air temperature, time of day, day of week
  - Whole building Option C savings analysis

For what fraction of buildings do we get a good automated baseline model fit?

- 54 of 84 total sites = 64%, over half
- 7 of 30 'bad fits' likely due to incorrect documentation of measure implementation date; models can be quickly re-fit



- Remaining 23 (27%) buildings would require engineer to investigate

What is the uncertainty in automatically computed gross savings – 95% confidence?

- Program data set 1:
  - Savings = 3.96% +/-0.3, i.e. between [3.66%; 4.26%]
- Program data set 2:
  - Savings = 5.9% +/- 0.8, i.e. between [5.1%, 6.7%]
- Program data set 3:
  - Savings = 6.5% +/-2, i.e. between [4.5, 8.5]

***Data set 1 larger, sets 2 and 3 small**

*How do M&V2.0 results compare to prior, traditional M&V results?

- Program data set 1:
  - Information not available for comparison

- Program data set 2&3:
  - Prior (aggregated) savings within 95% confidence interval of M&V2.0 results → statistically equivalent

***Limited number of buildings for which information was available – can't yet make a conclusion**

*How much time did M&V2.0 take vs. prior traditional M&V

- Program data set 1:
  - Implementer estimated 4 dys traditional Option C, vs. 1 dy 2.0

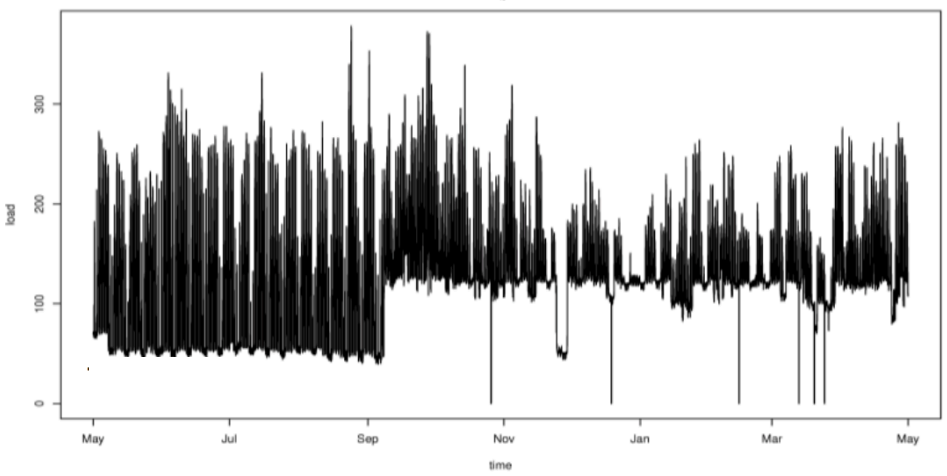
- Program data set 2:
  - Information not yet processed

- Program data set 3 (much smaller):
  - Implementer estimated 3-4 days traditional Option C vs. 1 dy for 2.0

***Back of the envelope estimates**

Some comments on non-routine adjustments

- Gross metered savings may not reflect gross program/measure savings
  - E.g. Occupancy or schedules may change or loads may be added/removed



- By definition, these Option-C compliant M&V2.0 baseline models do *not* handle NR Adj.

- It is possible that 2.0 analytics can flag cases where savings drop or increase unexpectedly, so that implementers can make timely inquiries of the site

Some comments on uncertainty, confidence, and documentation requirements

- General tool testing can tell us that we have good well-made hammers

- If we have well-made hammers, uncertainty and confidence can verify that we've driven our nails straight and true
  - But how straight do we need to be?
  - An how do we prove it to 3rd parties?
  - What documentation will we need?

80-20? 90-10? And how do we set these values?

Where Have We Gotten and Where are We Going?

Where have we gotten?

- Appreciation of the potential benefits of M&V2.0
- Replicable test procedures to assess overall robustness of M&V 2.0 tools for commercial buildings
- Initial exploration applying 2.0 to program data
  - Good confidence and uncertainty when applying M&V2.0
  - Start on defining practitioner workflows to retain a quality result
  - Indication of time savings
  - Indication that with interval data savings may not have to be as big as 10% to 'see' at the whole-building level

Future work

- Establish acceptance criteria and documentation requirements to prove that a robust tool was applied well, to generate a quality result

- Explore methods to auto-identify of non-routine events
- **Conduct structured pilots of M&V 2.0 to fully test the value proposition**

Test → Demonstrate → Scale

Thank You!

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For more detailed reports and presentations: eis.lbl.gov